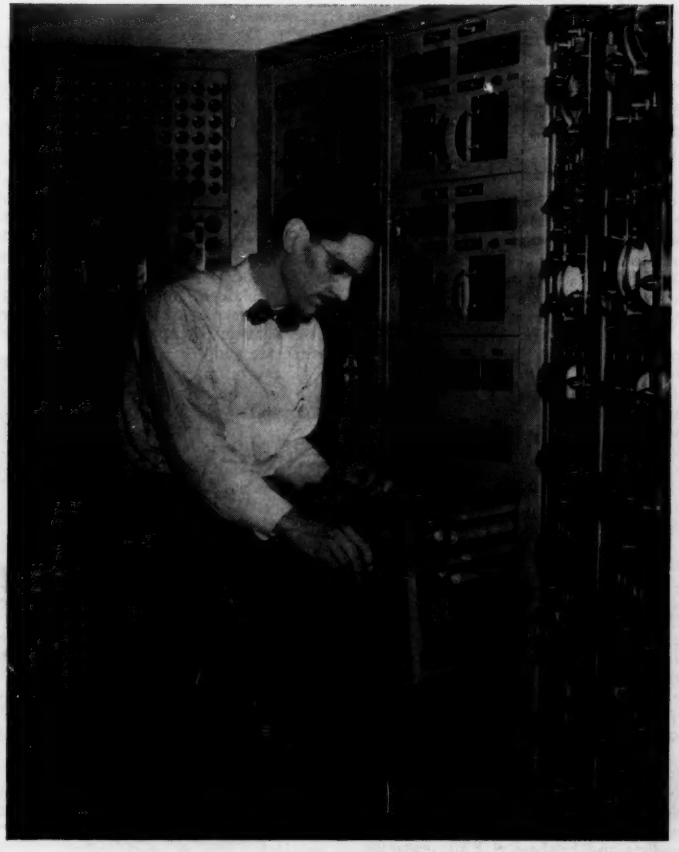
STATE ENGINEERING EXPERIMENT STATION

The Research Engineer

GEORGIA SCHOOL OF TECHNOLOGY

JANUARY ATLANTA, GEORGIA 1948



The Research Engineer

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EDITORIAL POLICY

Every journal, no matter what its type, is published to fulfill one or more purposes, and its articles are "slanted" to the audience in mind. THE RESEARCH ENGINEER is no exception, although its contents vary widely in field and in scope.

According to the first issue, which appeared in May, 1946, this journal was initially intended "to help to keep alumni and faculty abreast of the research and technical activities of Georgia Tech . . . and to bring all of these items to the attention of Georgia industry," so that, "through wider dissemination of information, it may aid in the development of Georgia and the South."

In keeping with this program and with plans for industrial and scientific symposia, economic studies, and such editorial departments as "Report From the Library" and "Recent Station Publications," THE RESEARCH ENGINEER has attempted to include material of interest to a wide audience without undue emphasis on any field of engineering or science or on any particular industry.

It might be of interest to note just who does receive and—we hope—read this journal. Distribution of the November issue was roughly as follows: alumni, 2,700; Georgia industrialists and bankers, 1,800; engineering experiment stations and major libraries and engineering colleges throughout the country, 700; Georgia Tech faculty members, 475; Georgia newspapers, 150; etc. In all, 6,300 copies were printed, representing an increase of 1,300 over the 5,000 copies obtained for the early issues, and current plans call for even wider dissemination of copies throughout the Southeast and the entire country.

In any technical journal of this size, of course, no one issue can be considered typical. Similarly, it is too much to expect that every article will be of interest to every reader, be he electrical engineer, industrialist, banker, chemical engineer, physicist, or mechanical engineer. What we are striving to produce, however, is a journal which depicts Georgia Tech endeavors and interests in those fields of engineering, science, and industrial economics which are naturally important to it. Since science recognizes no geographic boundaries, it is at once evident that the scope of THE RESEARCH ENGINEER is far from restricted.

Contributors often ask us, once a subject has been decided upon, "How should I write my article?" "Should it be technical or 'popular'?" "What about equations, diagrams, and tables?" These are legitimate questions, but they can be answered by no general

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GEORGIA TECH A-C NETWORK CALCULATOR

By H. P. PETERS*

As mentioned in Dr. Rosselot's article in the November, 1947, RESEARCH ENGINEER, the Georgia Tech A-C Network Calculator Laboratory has recently been placed in service. This article describes the laboratory in some detail and explains the principles upon which its operations are based.

The a-c network calculator recently installed by Georgia Tech is the largest and most modern in the country. Designed to handle the large, inter-connected power systems in the Southeast, it is actually of ample capacity to handle any power system in existence.

The Georgia Tech calculator is the fifth to be installed by an educational institution, previous installations being at the Massachusetts Institute of Technology, Purdue University, Illinois Institute of Technology, Texas A & M, and the University of Kansas. The Georgia Tech installation, however, is the first in which the equipment is operated without outside obligations as to its use; other college installations have been financed by groups of power companies, who receive a certain time allotment on the calculator each year in consideration therefor. At Georgia Tech, however, the calculator was presented to the school by the Georgia Tech Alumni Foundation and is available, on scheduling, to any company requiring the use of a calculator. This arrangement, it is felt, will fulfill most satisfactorily the need for a calculator located so as to serve, conveniently, the power companies of the Southeast. At present-day levels, the value of the calculator itself is about $150,000. It is installed in a new annex to the Research Building, this annex having itself cost $150,000.

The ground floor of this annex was designed specifically to house the network calculator laboratory, and the resulting arrangement is far superior to anything previously obtained. In the past, it has generally been considered satisfactory to furnish engineers with a network calculator installation having a limited number of other conveniences. The Georgia Tech calculator laboratory, however, occupies an air-conditioned suite of rooms consisting of a room for the calculator itself, a study room

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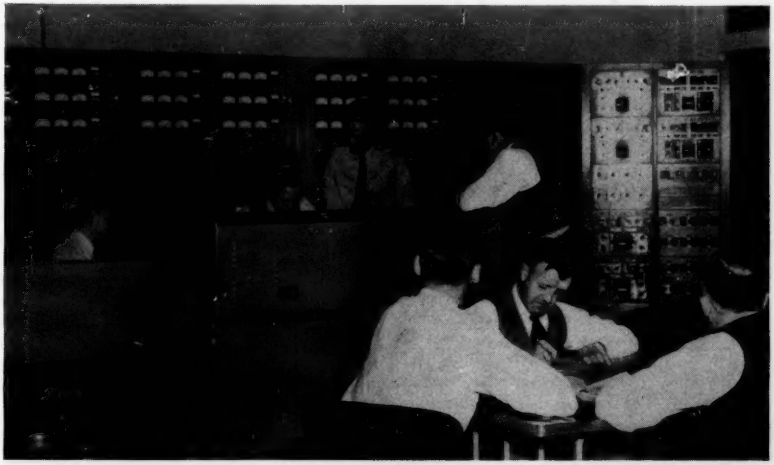

Figure 1. Partial view of the calculator room, showing a Georgia Power Company study in progress. In the left foreground are the plotting table and instrument desk.

with drafting facilities, a lounge room, offices for the supervisor and a technical secretary, and a room for possible later addition of equipment to study transient phenomena.

CALCULATOR DEVELOPMENT

The use of network calculators dates back to about 1920. At this time, power systems were reaching such a state of complexity that mathematical calculation of short circuit currents and other quantities was becoming almost impossible. At the same time, however, the necessity for knowing these quantities was steadily increasing, because of the very complexities that were making calculations impractical. To simplify the determination of short circuit currents, the most pressing problem, the direct current (d-c) network calculator was introduced in 1922. This calculator neglected the resistance of the various elements and assumed that all generators had internal voltages which were equal and in-phase, permitting the use of a single voltage source. These approximations were sufficiently accurate to give satisfactory answers to short circuit problems, where very large voltage drops are the rule. However, for determination of voltage regulation under normal load conditions, the d-c calculator was entirely inadequate.

To overcome the limitations of the d-c network calculator, the a-c network calculator was introduced about 1929. This calculator provided all the elements found in the actual power system, such as resistance, inductive reactance, capacitance, transformer turn ratios, and individual voltages adjustable in phase angle and magnitude, and could therefore be used to represent a power system with complete accuracy. The popularity of this equipment is indicated by the fact that, since 1929, 19 a-c network calculators have been installed in the United States, Georgia Tech's being the most recent. The Georgia Tech calculator was manufactured by the Westinghouse Electric Corporation, manufacturers of 12 of the 19 a-c network calculators in use.

In 1929, a-c network calculators were introduced almost simultaneously by Westinghouse and by the Massachusetts Institute of Technology working in conjunction with the General Electric Company. The M.I.T. calculator operated at 60 cycles, the Westinghouse calculator at 440 cycles. In 1937, General Electric brought out their own calculator operating at 480 cycles. The advantage of the higher frequency is that the physical size of the reactors and capacitors for a given impedance is much less than it would be at a lower frequency. Iowa State College is currently working on an experimental 10,000 cycle network calculator, a development which may further reduce the physical size of the calculator components but which introduces the serious problem of providing shielding to minimize the effect of stray capacitive coupling between the elements. No experiments have yet been conducted with full-size calculator equipment of this type.

Capacity coupling even at 440 cycles may introduce errors into the results of a calculator study. With the 100 volt, 1 ampere base used on the Westinghouse-built calculators, stray charging current is small enough to be neglected. If a base of 50 volts and 50 milliamperes is used, as on one standard calculator, the charging current becomes ten times as great (in percentage of the base current) as with a 100 volt, 1 ampere base and may require special precautions in spacing and shielding the wires.

DESCRIPTION OF EQUIPMENT

An a-c network calculator contains all the elements required to represent a power system. Resistor-reactor circuits are available to represent transmission lines, transformers, generator reactances, loads, etc. Condenser circuits are provided to represent line-charging capacity, synchronous condensers, and negative reactance. Auto-transformers represent actual turn ratios of transformers, and voltage sources represent system generators. All of these elements are so arranged that they may be easily and quickly interconnected and adjusted to represent the particular network under study. Adjustment of the impedance elements is accomplished by tap switches. These circuits are calibrated in per cent impedance which, with a 100 volt, 1

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INDUSTRIAL APPLICATIONS OF PSYCHOLOGY

By JOSEPH E. MOORE*

Psychology as applied to the behavior of man in industry—his abilities, suitability for specific positions, training, and efficiency—is a science of great present and future importance. The following article describes many of the factors involved, and their significance, and adequately presents the "why" of the industrial applications of psychology.

It has only been a little more than a generation since the need for the application of psychology to industry first became apparent. Today, however, whole journals are devoted to methods and research work in this field. Oddly enough, the industrial utility of applied psychology was first recognized by engineers and industrialists and not by the psychologists themselves. One of the first investigations in this field was made by two engineers, Taylor and Gilbreth, whose time and motion study has proved invaluable because of the controversy and stimulation of research it created on the subject of fatigue and individual differences.

Industry, quite naturally, is interested fundamentally in output or production, and industrial psychology, therefore, is concerned with the human factors which influence production. In the early investigations, the human factors were so oversimplified that man was looked upon more or less as a machine, an error shared alike by industrialists, behavioristic psychologists, industrial engineers, and "efficiency experts." Out of early misconceptions have gradually grown recognition and respect for human values and individual differences as related to production, along with the need for discovering and predicting these factors. The knowledge of an employee's possibilities and limitations has proved invaluable in placing and promoting him. A man in a job too simple for his capabilities is likely to become discontented and to reduce production, while the same man in a job too big for him can become

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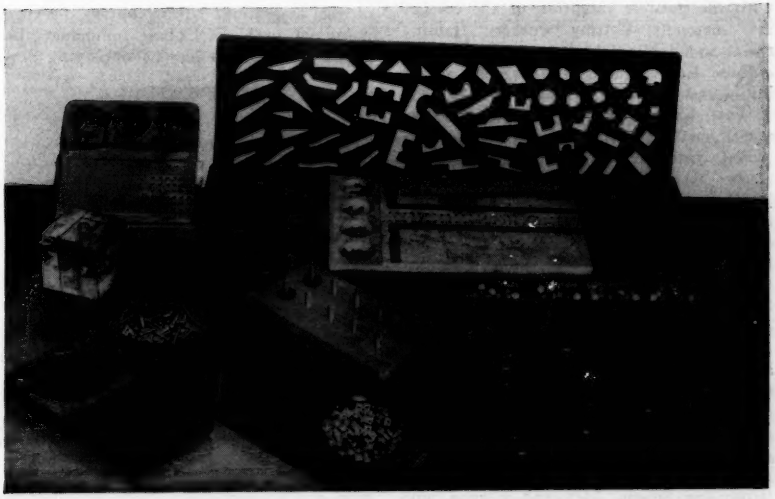

Figure 1. Various test equipment for psychological analysis of abilities.

worried and over-anxious to the point of a complete breakdown, thereby halting his part of the production process. The recognition of the complexity of the human being was the first great stride in the advancement of industrial psychology.

The second most valuable step in advancement has come about as a result of the psychological services used by the Armed Forces in World War II. Classification tests were used to determine the fitness of inductees for various branches of the service, such as aviation, marine warfare, etc. Mistakes were made, of course, and rectified to some extent, all of which knowledge industry is now able and willing to use to advantage. Wartime psychologists also worked with medical men on problems of fatigue, training programs, and tests for identifying mental cases; propaganda workers were in many cases assisted by psychologists. New applications of many of their findings remain to be worked out and will doubtless mean greater efficiency and savings for industry.

THE VALUE OF PSYCHOLOGICAL METHODS

The cost of labor is the greatest single economic factor in the production process, with the possible exception of the cost of raw materials. Getting workers, training them, and holding them are expensive procedures. Let us look, for example, at the initial cost of a new worker.

The Dennison Manufacturing Company[15] has reported that every new employee costs them $80 before he or she reaches average production. Labor turnover is of great concern to the Milwaukee Electric Railway and Lighting Company[15] because they invest $217 in each new trainman hired. In a different field, a representative of the Liberty Mutual Insurance Company told the writer that the training costs of certain salesmen run as high as $1,000, a figure which includes training, salary, the cost of teachers, etc. One industrial plant in Atlanta reports that only one out of every four applicants hired has proved satisfactory.

The value to industry of psychological testing also extends beyond the initial selection procedures. Men and women who have been tested can also be placed more accurately within the plant, at a saving to the company. The Employment Department of Allis-Chalmers Manufacturing Company takes a very positive stand on the use of tests, as can be seen in the following statement: "However, from tests we have found that there can be a difference roughly in the ratio of as high as two to one in mathematical ability, mental alertness, interests, and personality between engineers, even though they may have been exposed to the same courses at the same college. This has been proved by our experience with tests . . . Our use of such standardized tests has led us to definite conclusions concerning the characteristics young engineers should possess before they can hope to reach the greatest achievement in the above fields of engineering."[2]

GROWING INDUSTRIAL USE

A recent survey[13] of 36 large companies or corporations, employing a total of 815,000 employees, was concerned with their policies in regard to the application of psychology to personnel work. The 16-item questionnaire employed brought forth the responses presented in Table I.

The data given by these 36 large industrial concerns indicate that they approve of the adaptations of psychology to their industrial problems. These companies also appear to favor the idea of employing pro-

Figure 2. Taking the eye-hand coordination and color-matching test developed by the author.

TABLE I

QUESTIONNAIRE AND ANSWERS ON
CORPORATION APPLICATIONS OF PSYCHOLOGY TO PERSONNEL WORK[13]

Does Your Company Have:			Do You Consider This Desirable?	
Yes	No		Yes	No
%			%	
72	17*	1. A unified personnel office?	75	6
56	42	2. Tests of intelligence for applicants?	70	3
58	36	3. Tests of performance for applicants?	64	11
58**	28	4. Preference in employment to college men?	44	14
14	81	5. Periodic check on the morale of employees by attitude tests?	47	17
30	64	6. Professionally trained psychologists in the Personnel Department?	53	19
78	19	7. Training program for new employees?	83	0
83	8	8. Training program to show supervisors how to deal with men?	81	0
83	14	9. Formal system for expression of employee grievances?	75	3
42	53	10. Employee counseling system?	53	11
67	25	11. Employee merit-rating system?	70	14
			Yes	No
			%	
		12. Do you compile figures on labor turnover each year? If so, what is your normal yearly figure?***	83	6
		13. Do you compile figures on absenteeism? If so, what per cent of regular time are employees normally absent?	64	17
		14. Do you have an organization comparable to a labor-management committee?	39	19
		15. Does your company look with favor upon the applications of psychological methods to personnel relations?	70	8
		16. Approximately how many employees do you have?	(Average)	22,600

*Figures do not add to 100 per cent because some respondents answered only a few items.
**Most respondents specified that this applied only to technical or prospective executive employees.
***Figures on turnover and absenteeism were supplied only by a minority of firms, and some of these were apparently on differing bases.

fessionally trained psychologists in their plants.

Three of the South's largest industrial organizations, the Union Bag & Paper Corporation, the General Shoe Corporation, and the Marshall Field & Company's textile mills, have employed well-trained psychologists. These large companies have all placed these psychologists in the personnel and research departments of their plants. The psychologist's work with the Union Bag & Paper Corporation proved so valuable that the following statement was inserted in the company's 1946 annual report: "The scientific induction tests which are given to prospective employees are proving particularly valuable in determining the suitability of the job to the capabilities of the applicant."

The differences between good and poor workers are often very great. The alert employer will select workers who possess the abilities which his plant demands. The importance of individual differences in employee ability can be judged from the following data taken from a recent report[4] of the Union Bag & Paper Corporation at Savannah, Georgia. On a test of mechanical comprehension taken by 1,362 white men, the scores ranged all the way from 9 to 55 points. On a mental ability test, 1,362 white men varied from 31 to 115 points. Women applicants for office jobs varied all the way from 57 to 112 points in their ability to look at two series of numbers and check whether they were alike or different. In checking names, the same group of women ranged from 47 to 173.

In study of supervisors in Southern textile mills, Harrell[8] found that the score of the best supervisor was 35 points above that earned by the poorest supervisor on a test of mental ability. A few supervisors who were rated excellent by their employers scored low on the mental tests given by Harrell.

In another investigation[5] carried on in the A. C. Spark Plug Division of General Motors Corporation, a battery of tests showed that 69 per cent of the individuals who scored in the high third were also rated in the high third by supervisors, while none of those rated in the low third received scores in the high third of the group.

The Ford Motor Company has used a hand dexterity test, a finger dexterity test, and a test wherein the subject rivets by touch rather than by sight.[1] "Foremen agreed that workers selected by the use of tests were superior to those selected by regular methods."

It is time, now, to mention specifically some of the particular duties of an industrial psychologist.

SELECTING NEW EMPLOYEES

One of the most frequent jobs of the industrial psychologist is the initiation and supervision of employee selection systems. He is called upon to study job requirements, descriptions, and specifications and to select employees for the jobs in question. In order to do an adequate job of selection, of course, he must be well acquainted with the field of aptitude testing—how to devise tests, to apply them to applicants, and to check the results against job success in the plant.

The types of psychological tests most frequently used in selecting employees for industrial and business firms are: (1) general intelligence, (2) special ability (manual dexterity, clerical and computational ability, etc.), (3) trade or achievement (bookkeeping, carpentry, mechanical, typing, etc.), (4) personality and adjustment inventory, and (5) interest inventory.

These tests, like all tests, are samples of human behavior and hence are not infallible. Testing programs sometimes fail, moreover, because the limitations of tests are not understood or appreciated. Such a program has no place for an over-enterprising personnel officer, eager to demonstrate his ability. In testing it can truly be said, "A little learning is a dangerous thing."

The value of tests in selecting and placing employees may be judged from specific reports from various companies.

"Allis-Chalmers started its engineering training program more than 42 years ago and has followed a policy of continuing to improve it from time to time. Perhaps the most important of these advances occurred four years ago when we started to administer psychological tests to some of the young engineers on our graduate training course after they were employed. This gives us an invaluable scientific basis for counseling them and guiding them into the right assignment among numerous types of work available in so large and diversified an organization as Allis-Chalmers."[2]

In a different field, Neal Drought, manager of the Personnel Policy and Research Division of the Radio Corporation of America, states: "We have found in our plants that manual dexterity tests greatly reduce training time by screening out slow from fast applicants, particularly in assembly operations."[3] In still another field, John H. Asherfelter, personnel director for the Sun Oil Company, says, "We use performance tests in various departments. Truck drivers must pass a driving and mathematical test. Office help must prove their efficiency in stenography and typing."[4]

TRANSFERS AND PROMOTIONS

The use of psychological tests to select employees is only the very beginning of a useful program. Test results may assist the personnel director in transferring employees from one job to another. In this manner, workers may be transferred to jobs that challenge their ability. As mentioned, some employees fail because they get bored with details too simple for their mental capacities. Similarly, men work under strain and often fail when they are placed in tasks too difficult for them.

The selection of employees for *upgrading* and *promotion* is in many instances the most important personnel step that management takes. To make intelligent selections for upgrading requires careful analysis of many facts, because of the possible effects on plant morale. Objectivity, therefore, is vital. Mental test ratings, aptitude and achievement test scores, and performance or production records give a fair and objective basis for promotion. One investigator has studied the value of aptitude

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THE USE OF COLOR PHOTOGRAPHY IN THE EXPERIMENTAL FREEZING OF FOODS

By W. B. COWN* and T. W. KETHLEY**

This is the second RESEARCH ENGINEER article dealing with the research on food freezing now under way at the Georgia Tech Engineering Experiment Station, a project jointly sponsored by the Tennessee Valley Authority. A brief description of color film processes is presented, followed by details of their applications to the recording of color changes which occur as foods are treated.

Throughout the work on the broad program of research on food freezing now under way at Georgia Tech, considerable emphasis has been placed upon the recording of the physical characteristics of foods in order to determine what changes, if any, are brought about by the freezing process. One of the most important physical characteristics of a food is its color, not only because a change in color apparently indicates a departure from the normal that must be caused by some chemical or physical variation, but also because such a color change usually makes a product less acceptable to the consumer.

Studies which have been made here on the recording of colors in foods have shown that color photography offers great possibilities for research in this field, and, accordingly, much work has been performed with the object of perfecting techniques for its use here in research on frozen foods. Before discussing this work, however, a brief description of the processes involved in color photography seems in order, so that the problems that were encountered in establishing procedures may be better understood.

METHODS

There are two general physical methods which may be used in color photography; namely, the addition or subtraction of colors. The former depends upon the addition of the additive primary colors—red, green, and blue in the form of red, green, and blue lights. Color gravure provides a familiar application of this principle; microscopic dots of red, green, and blue over the picture area are added together by the eye without perception as such of the individual dots. In photographic practice, this method is applied by first making three exposures through three filters—red, green, and blue-violet, producing three separate negatives which are referred to as "separation negatives." After these negatives are developed and printed, the positive transparencies are projected through three filters (red, green, and blue), similar to the filters used for taking the pictures. The three resultant pictures, when superimposed in register on a screen, render a satisfactory color picture of the original subject. Difficulties are encountered in applications of this process, however, since the three images must be exactly equal in size to register accurately in the final reproduction; otherwise, fringing and distortion occur, and good color rendition cannot be achieved.

Some of the undesirable features of the above system are eliminated by combining three separate films, one behind the other, with each film sensitive to one of the primary colors. When exposed in such a combination, each of the three films records only the light of the color to which it is sensitive. This arrangement is best known in the field of color photography as the tri-pack. Many objections to this arrangement are removed by a further variation—coating three separate emulsions, one directly over another, on a single support, so that the emulsions are in optical contact and hence, for all practical purposes, are in the same plane of focus. This is known as the mono-pack.

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The subtractive color photography process is a direct outgrowth of the monopack principle. A simple, direct, and practical means for coloring images in the superimposed emulsion layers of a monopack film for color photography is achieved by the use of developers containing colorless, dye-forming substances which produce colored dye images along with a black-silver image when the exposed film is processed in such solutions, the reaction products of development (insoluble, colored dye images) being produced in exact proportion to the black-silver image. By removing the black-silver image, only the transparent, colored dye image remains. In such a case, each emulsion layer is sensitive to one of the additive primary colors, red, green, and blue. After exposure, and during development, dye images are produced in each layer in one of the *subtractive* primary colors—yellow, cyan (blue-green), and magenta (blue-red), in amounts controlled by the black-silver image, which here is equivalent to the separation negative. Removal of the silver from the film leaves only the composite colored image formed by the three superimposed images.

To describe this process in more detail: when rays of white light strike this triple-coated film, the top emulsion records blue light only, with the green and red passing through. A yellow filter layer placed above the middle emulsion prevents any blue light from reaching the two lower emulsions. The middle emulsion is sensitive to green light but not to red, and the bottom emulsion records red light only. During the first development, black and white images (separation negatives) are formed which later control the amount of color developed in each emulsion layer. This development step is followed by a second exposure to white light which makes all the residual silver bromide developable, with the amount of silver bromide remaining in each layer depending on the negative image; thus, positive silver images are formed when the film receives a second development. These positive images are "complementary" to the negative images first developed in the film, and, in a like manner, the positive dye image formed in each emulsion layer is of a color complementary to that color recorded by the individual layer during the original exposure. The black-silver is then removed, leaving the three superimposed images to form a composite colored image in the primary colors. Intermediate colors and mixtures are obtained by partial adsorption at each emulsion layer, and heavy adsorption in all three layers subtracts light of all colors, resulting in neutral grays or blacks. Because only the colored dye image remains, this film is transparent to light and is referred to as a *transparency*.

COMMERCIAL COLOR FILMS

These are the principles upon which are based all of the popular reversible color films, such as Kodachrome, Ektachrome, and Ansco. These films differ chiefly in their coloring methods and color-forming substances. Either the dye is formed in each layer of emulsion by separate developers for each emulsion, or the dye is already in each emulsion layer and the composite film requires only one color developer. In the first case, the developing process is so complicated that it is usually carried out by the manufacturer; Kodachrome is an example of this type of color film. Color film such as Ansco and Ektachrome, however, requires only one color developer and can be processed by the user.

Investigation here of the possible methods of producing color photographs showed that the color films most suited to the experimental work on frozen foods are Ansco or Ektachrome, because, as just mentioned, they can be developed by the user. The time lag involved by the necessity of returning such films as Kodachrome to the manufacturer for processing would introduce such delays in the examination of the films as might lead to large errors, since it would be impossible to compare the color films with the original materials. Moreover, it would prevent the retaking of exposures which failed for one reason or another.

EQUIPMENT

After an analysis of the cost of various sizes and types of color film, it was decided

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GEORGIA FARMS AND THE FOREST PROBLEM

By JOSEPH B. HOSMER*

Georgia, today, is already a major producer of wood and wood products, but its potentialities may not be fully realized if attention is not given to those economic factors which have limited past development. One of these factors is the lack of proper growing methods for trees on farm wood lots, a subject discussed in detail in the following article.

The United States during the next 75 years will be more and more dependent on the Southeast for timber products. This is the inescapable conclusion to be derived from the three pamphlets, *Reappraisal of the Forest Situation*, recently issued by the United States Forest Service of the Department of Agriculture.

Study of the Forest Service data on "farm wood lots," however, indicates that there is a possibility that this "neglected" forest classification may be utilized to shorten considerably the 75-year period which the Forest Service estimates will be required to establish a balance in the supply and demand of forest products.

The amount of the annual growth of timber, naturally, measures the maximum quantity of timber which may be used without depleting the stock of trees in the forests. The actual limit, of course, is necessarily lower, since nonproductive drains on forests such as fire loss, trees destroyed by disease and rot, and the waste incident to cutting and processing must all form a part of the annual growth. For 1944, the Forest Service estimated the annual growth by broad areas as follows; 75-year goals are also shown:

ANNUAL GROWTH OF TIMBER

	Billion Cubic Feet		Per Cent	
Region	1944	75 Year Goals	1944	75 Year Goals
North	4.67	5.78	34.93	28.90
South	6.39	10.14	47.79	50.70
West	2.31	4.08	17.28	20.40
Total	13.37	20.00	100.00	100.00

The Forest Service's "South" includes three subareas: (1) West Gulf, including East Texas, Arkansas, and Louisiana; (2) Southeast, including Mississippi, Tennessee, Alabama, Georgia, and Florida; and (3) South Atlantic, including South Carolina, North Carolina, and Virginia. All of these southern states with the exception of East Texas and Arkansas are often included in other definitions of the "Southeast," so that the preceding table, in broad generality, says that in 1944 the South (mostly the generally-defined Southeast) had approximately one-half of the annual timber growth and that it is expected that this percentage will be maintained during the next 75 years, during which time total growth will increase.

The Forest Service's "Southeast" (Mississippi, Tennessee, Alabama, Georgia, and Florida) had 2,710,000,000 cubic feet of annual timber growth in 1944, or 20.27 per cent of the United States' total. The 75-year goal for the "Southeast" was set at 4,800,000,000 cubic feet, or 24 per cent. These summary figures clearly highlight the importance of Georgia and the Southeast in the future of the national forest picture.

The major long-range problem in meeting the growth goals set up by the Forest Service is represented by the farm wood lots. In the United States as a whole there are 402,771,000 acres of forests, of which 123,474,000 acres (30.66 per cent) are included in farms. In the Forest Service's "South," the total forest land is 165,058,000 acres, of which 60,843,000 (36.86 per cent) are in farms, while in the Forest Service's "Southeast" there are 83,861,000 acres of forests, of which 30,720,000 (36.63 per cent) are in farms. Cutting practices, for reasons which will be discussed later, are poorest on farm wood lots. Table I presents all these data in full detail; from this table the following summary statements may be derived:

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TABLE I

CHARACTER OF TIMBER CUTTING[1]

Region	Operating commercial forest area, thousand acres	Per Cent of Cutting[2]				
		High order	Good	Fair	Poor	Destructive
All Forest Types						
South	165,058	4	13	23	54	6
South Atlantic	37,507	1	13	30	54	2
Southeast	83,831	2	11	24	54	9
West Gulf	43,720	11	15	17	54	3
North	152,261	2	15	26	50	7
West	85,452	1	45	29	21	4
All Regions	402,771	3	20	25	46	6
Private Ownership Over 50,000 Acres						
South	22,867	11	41	25	20	3
South Atlantic	2,754	—	44	16	40	—
Southeast	10,062	4	36	36	20	4
West Gulf	10,051	20	44	17	15	4
North	15,068	—	9	62	29	—
West	11,900	—	9	38	43	10
All Regions	48,635	5	24	39	28	4
Farm Woodlands						
South	60,843	—	3	24	68	5
South Atlantic	20,016	1	4	28	65	2
Southeast	30,720	—	2	24	66	8
West Gulf	10,107	—	1	17	79	3
North	56,131	—	5	22	62	11
West	6,500	—	4	28	54	14
All Regions	123,474	—	4	23	65	8

[1]Source: U.S.D.A., Forest Service, *The Management Status of Forest Lands in the United States*, 1947, Table 13.

[2]More specifically, the per cent of operating acreage now being managed under each cutting practice described below:

(1) High-order cutting requires the best types of harvest cutting which will build up and maintain quality and quantity yields consistent with the full productive capacity of the land. Wherever needed, it requires timber stand improvement cuttings, planting, and control of grazing.

(2) Good cutting requires that the cut be made in accordance with good silviculture and that the land be left in possession of desirable species in good condition for future growth. It is substantially better than the class below and should contain some of the elements of the class above.

(3) Fair cutting marks the beginning of cutting and cultural treatments which will maintain the land with any reasonable stock of growing timber in species that are desirable and marketable.

(4) Poor cutting leaves the land with a limited means for natural reproduction—often in the form of remnant seed trees on broad areas otherwise clear-cut of all merchantable timber. In second-growth forests, poor cutting robs the stand of minimum-size merchantable trees in stages of rapid growth. Such cutting often causes deterioration of species with consequent deterioration in both quantity and quality of forest growth.

(5) Destructive cutting leaves the land without timber values and without means for natural reproduction.

1. The cutting practices on 73 per cent of all farm wood lot acreages are *poor* or *destructive*, while for large private holdings (over 50,000 acres) only 32 per cent are so classified.

2. Cutting practices in the Forest Service's "Southeast" are slightly worse than for the United States as a whole; 74 per cent are classed as *poor* or *destructive*, while for the "South" the ratio is 75 per cent. However, only 24 per cent in the "Southeast" and 23 per cent in the "South" of the practices of large private owners fall in these categories.

The greatest opportunity for forest improvement in Georgia and the Southeast, then, lies in improving the status of the forest land now included in farms. One is forced to add, however, that the difficulty involved is probably even greater than the opportunity.

To reach its 75-year goal, the Forest Service has assumed that most farm ownerships will attain an "extensive" level of management. By definition, this implies "at least fair" cutting and "good" fire practices. The status of farm wood land in respect to these standards in 1944 (latest year for which figures are available) is well below these assumptions. Summarized

Continued on Page 23

REPORT FROM THE LIBRARY

By DOROTHY CROSLAND*

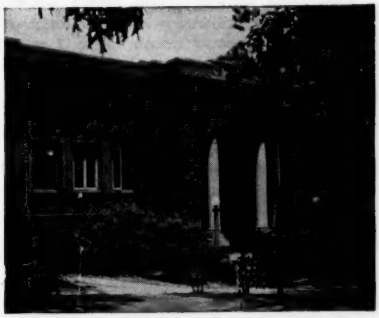
In this scientific age, the periodical literature is of great importance, but to use periodicals effectively the research scholar must have access to as many indexes as possible. These are important bibliographic tools because they can save librarians, literature searchers, and research students hours of valuable time. Without an index, no journal can be very useful. The literature it contains may be highly important, but, unless it is indexed, it becomes almost valueless because it cannot be found.

Just recently, we had an inter-library loan request from the librarian of a large industrial organization, the New York Public Library having reported to that company that we had the only complete file of the particular journal needed. The request was for an article on "corrosion of mineral spirits," published "sometime around 1928-1930." The journal in question is not indexed, and the papers and articles in it have very poor headings. In cases like this, one must spend hours searching for a subject that could be located in a few seconds if only the journal were indexed.

Many libraries build their own periodical or bibliographic indexes. Just as a single volume may have its own index, a library may have an index of the contents of its periodicals or books. For example, there is an excellent subject index to scientific and technical periodicals in the Library of the Science Museum, London. Using this index, the library publishes valuable subject bibliographies, among which are the following, recently received by our library:

No. 631. Vacuum Melting, Distillation, and Sublimation.
No. 632. Technical Glossaries and Dictionaries..
No. 633. Manufacture of Oxygen by the Kapitza and Linde Processes.
No. 634. Books and Periodicals on Air Conditioning Published in England, 1932-1945.
No. 635. Books and Periodicals on Refrigeration Published in England, 1929-1945.

*Librarian, Georgia School of Technology.



No. 636. Journals on Pure and Applied Chemistry in Languages Other than Latin, Teutonic, and Russian.
No. 637. Books on Spinning and Weaving of Cotton and Rayons, Mainly 1930-1936.
No. 638. Food Preparations from Ground-Nut Cakes.

In Zurich, Switzerland, at the Bibliothek der Eidg. Technischen Hochschule, one may find another great periodical index. The librarian there is doing an excellent job of providing bibliographies for engineering science students and workers throughout the country. Periodicals are indexed as rapidly as they arrive in the library. Once each month the Swiss technical journal, *Technische Rundschau* of Berne, publishes a subject bibliography of recent scientific and technical articles which is edited by the assistant librarian. This index, with its current information, serves as a very valuable bibliographic tool.

In our own country, we have numerous periodical literature indexes. The *Industrial Arts Index* and the *Engineering Index* are essential to any engineering school library. The latter index is published annually in book form; however, Engineering Index, Inc., also publishes a current subject card index. This library has only been subscribing for these cards for the past several months, but we are already finding them very useful. Students and faculty members

are delighted not to have to wait a year for *Engineering Index* material.

There are numerous other indexes, abstracts, and bibliographies that make the bibliographic section of our library strong. Unfortunately, however, our building is so crowded that we cannot have a room devoted to bibliography. Nevertheless, the following indexes, abstracts, and bibliographies may be found on our reference shelves:

Air Documents Index, 1946- . Issued by the Air Materiel Command, Wright Field, Ohio. In card index form, covering all the captured German and Japanese data and also U. S. Army Intelligence Reports.

Aeronautical Index, 1931- . Subject card index of over 50 aeronautical periodicals, publications of the National Advisory Committee for Aeronautics, and reports and memoranda of the Aeronautical Research Committee for Aeronautics, all indexed by the aeronautics librarian and staff of the Georgia School of Technology.

Aeronautical Index. A subject and author index to aeronautical periodicals and technical reports, 1938; issued in cooperation with the Institute of Aeronautical Sciences. Library of Congress, Washington, D. C. 1939.

American Society for Metals. *A.S.M. Review of Metal Literature*, 1945-1946, 3 vols. A cumulation of abstracts which appear in *Metals Review*, indexing 168 periodicals. Cleveland, Ohio.

Bibliography of Agriculture, 1942- . An index of books, periodicals, and all related agricultural material received in the U. S. Department of Agriculture Library, Washington, D. C.

Bibliography of Scientific and Industrial Reports, 1946- . Lists and abstracts of thousands of the latest technical documents and reports received by the Office of Technical Services from American and foreign sources. Key guide to technological developments underlying the war efforts of our own and enemy countries. Government Printing Office, Washington, D. C.

Biological Abstracts, 1926- . A comprehensive abstracting and indexing journal of the world's literature in theoretical and applied biology, exclusive of clinical medicine. University of Pennsylvania, Philadelphia.

Biometrika, 1901- . A journal devoted to the statistical study of biological problems. University College, London.

British Abstracts, 1924- . Sections A, B, and C. These are continuations of the abstract sections of the *Journal of the Society of Chemical Industry* and the *Journal of the Chemical Society*. Abstracts of the chemical literature, patents included. Bureau of Abstracts, London.

Ceramic Abstracts, 1922- . Abstracts of the literature on ceramics and related subjects published in America and some foreign countries; patents are included. American Ceramic Society, Columbus, Ohio.

Chemical Abstracts, 1907- . Over 2,800 periodicals, from all countries, are currently abstracted. This is the most useful of all chemical abstract journals. Patents are included. American Chemical Society, Washington, D. C.

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Engineering Index, 1884- . A subject index of the literature of all branches of engineering, covering more than 2,000 periodicals, transactions, reports, etc., in 20 languages. The *Engineering Index Service* is the comprehensive guide to the contents of this literature. Important articles, papers, and reports dealing with all phases of engineering are classified, indexed, and annotated on cards which are distributed weekly. Engineering Index Service, New York City.

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Natural and Synthetic Fibers, 1944- . Contains abstracts of information relating to textiles. Includes patents. Interscience Publishers, New York City.

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Psychological Abstracts, 1927- . Abstracts from domestic and foreign periodicals on specific phases of psychology. American Psychological Association. Lancaster, Pennsylvania.

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Refrigeration Abstracts, 1946- . Literature and patent abstracts grouped under general refrigeration subjects. American Society of Refrigerating Engineers, New York City.

Resins, Rubbers, Plastics, Abstract Service, 1942- . A loose-leaf literature and patent index to material available in the field. Gives complete references to the original articles, and includes illustrations and diagrams. Interscience Publishers, New York City.

Science Abstracts, 1898- . Divided into two parts: Section A. Physics; Section B. Electrical Engineering. Abstracts of articles appearing in more than 250 publications in various languages. Institution of Electrical Engineers, London.

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GEORGIA TECH A-C NETWORK CALCULATOR

Continued from Page 4

ampere base, is equal to the physical ohms. The capacitor circuits are adjusted by toggle switches and are calibrated in per cent susceptance. The voltage sources consist of an induction regulator and phase shifter and are adjusted by controlling the rotor position of these devices. All the elements are housed in drawer units, removable from the front of the steel cabinets. The various elements are terminated on connection panels, where they may be interconnected into any desired network. An ingenious plugging arrangement allows this interconnection to be made quickly and easily.

USES

The calculator has been primarily designed to facilitate the study of power systems, and the resistor-reactor circuits have a range to cover that found in such systems. These circuits are divided into two classes—"line" circuits of resistance and reactance in series, and "pi-line" circuits with the same resistance and reactance but with capacitors at each end to represent the line-charging capacity of long, high-voltage transmission lines. The "load" circuits provided are resistor-reactor circuits of extended range, to represent the shunt loads of a system. These circuits have facilities for connecting the resistance and reactance either in series or in parallel and are equipped with a "load-adjusting" auto-transformer, so that the power taken by the circuit may be maintained with variation of bus voltage. "Generator" circuits are available which provide a voltage output adjustable in phase angle and magnitude and may therefore represent a system generator. The "auto-transformer" circuits represent the difference in turn ratio between that used for the impedance conversion and that dictated by the actual transformer turn-ratio. "Mutual" transformers are available to represent the mutual induction between circuits in close proximity and to be used as 2-to-1 transformers in problems requiring the use of a double impedance base.

Although the calculator is primarily designed to represent a power system, it can be used to represent any linear electrical network, and, in this capacity, it may be of considerable value in research work. The calculator elements have in the past been used, in conjunction with a synchronous switch, to study transient conditions on a power system, such as the magnitude and frequency of recovery voltages following a short circuit or switching operation. They have also been used to study gas flow and heat transfer problems and will, in the future, probably be used for many other problems for which an electrical analogue can be drawn.

THE GEORGIA TECH CALCULATOR

One of the outstanding features of the Georgia Tech calculator is the inclusion of the large number of pi-line circuits. On other calculators, the line-charging capacity of all lines terminating on a bus must be lumped in one condenser on that bus. When the reactive power in a line section is read, the effect of the charging current is lost. In order to obtain a true line reading, that part of the lumped capacity pertaining to the line must be added in, considering direction of flow and bus voltage. With pi-line circuits, individual condensers are provided at each end of the circuit, and the reading obtained on the instruments contains the line-charging kva and requires no correction. This feature will be greatly appreciated by engineers working on high-voltage systems with long lines.

The Georgia Tech calculator is arranged around three walls of the room which it occupies, in a continuous U-shape. The pleasing appearance of this arrangement, however, is only incidental to the original reason for it. With this arrangement, the leads from the circuit cabinets to the connection panels are of the minimum possible length, and, therefore, stray resistance is kept to a minimum, an important consideration in a calculator operating at the power level which has been employed. All

the circuits requiring adjustment during the course of a study are conveniently located adjacent to the instrument desk, so the physical effort and time required for operation is held at a minimum.

Determination of voltage levels and power flow in any equivalent circuit is made entirely from the instrument desk, shown in Figure 2. Each circuit has associated with it a "metering" relay which, when energized, connects that circuit to the master instruments on the instrument desk. The selection of the metering relay to be energized is made from the instrument desk through a "group and point" selector, controlled by a 26-button keyboard. Selection of a circuit for metering connects that circuit to a set of "scalar" instruments or to a set of "vector" instruments, at the operator's discretion.

The scalar instruments are standard, precision instruments and operate through negative feed-back amplifiers to give scalar values of voltage, current, true power, and reactive power. These instruments are provided with three voltage ranges and five current ranges. The equivalent voltmeter resistance is 1000 ohms per volt, and the voltage drop in the ammeter for full scale deflection is 0.06 volt.

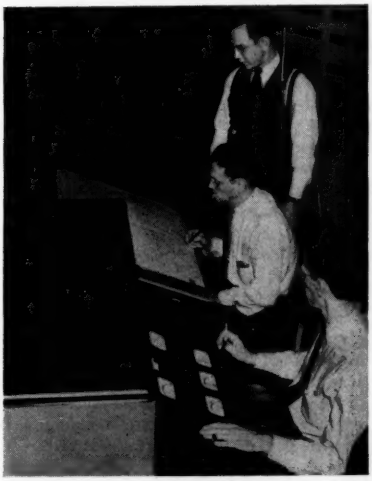

Figure 2. Instrument desk and plotting table (foreground and background, respectively). This combination prevents misunderstandings and speeds the completion of studies.

The set of vector instruments may be used when it is desired to read currents and voltages in vector or polar form. The instruments are actually dynamometer wattmeters, one calibrated as an ammeter and one as a voltmeter. One coil of each instrument is supplied from a metering phase-shifter, the phase position of whose output voltages may be readily controlled. They are so designed that most of the energy required is supplied from the standardizing coil, and the burden they put on the network is very low.

Since in normal problems scalar voltage, watts, and vars are the quantities required, the scalar instruments are used most of the time. Provision is made on the instrument desk so that the voltage, watts, and vars may be read at either end of the circuit, or the voltage drop, watts, and vars lost in the circuit may be read.

The Georgia Tech calculator is physically the largest in existence today. The word "physically" is used advisedly because of the errors introduced when total circuits are used as a basis for size. Because of the large number of pi-line circuits on this calculator, the required number of condensers has been reduced. In any tabulation of total circuits, this factor has considerable influence, since a large number of condensers can be put in a small space. If the pi-line condensers were considered as circuits, they would add 144 to the total circuits and would give the largest total (466) of any calculator yet built. The Georgia Tech calculator has 160 impedance circuits (88 line, 72 pi-line), 60 load circuits, 24 condenser circuits, 18 generator circuits with reactances, 24 auto-transformer circuits, and 18 mutual transformer circuits.

Calculator facilities at Georgia Tech also include a plotting table, a device first introduced by the .Illinois Institute of Technology. In the past, it has usually been the custom to record the results of a study (instrument readings) in tabular form. In order to analyze these results, they then had to be plotted on a one-line dia-

gram of the power system, requiring two steps between the completion of a study and obtaining the results in usable form. This delay often meant that errors of reading or operation could pass undetected for some time and that, when they were discovered, another study was usually in progress on the calculator, making it a major operation to obtain the correct values. The first step to improve this situation was the arrangement of the instrument scales and the selection of impedance bases so that instrument readings were direct system quantities, thus permitting instrument readings to be plotted directly on the system diagram.

To further facilitate this process, the plotting table was then devised. It operates through the circuit selectors and is so set up that when a circuit is selected for metering, a light on the plotting table comes on at a location in the system corresponding to the location of the instruments. This prevents any misunderstanding between the instrument reader and the plotter as to what circuit is being metered, and it reduces considerably the time required for the complete representation of the results of a study. The Georgia Tech plotting table, shown in Figure 2, is of unique design and has 3500 possible lamp locations, located at 0.5-inch intervals on a 24 by 36 inch panel.

It seems highly probable that this new a-c network calculator will prove a valuable teaching and research instrument, in addition to providing a much-needed tool for the public utility systems of the Southeast.

INDUSTRIAL APPLICATIONS OF PSYCHOLOGY

Continued from Page 8

tests for selecting supervisors. His study[12] included three different aircraft engine and propeller plants, and he concluded: "The promotability of minor supervisors such as group leaders and job setters was found to be related positively and significantly with test scores."

In trying to improve selection techniques and to develop a better group of supervisors, management has often turned to psychological tests. In some instances, the instruments employed have helped to select suitable persons for supervisory responsibilities. It cannot be stressed too strongly, however, that the mere application of tests does not guarantee good results. In a study of supervisors in an aircraft plant, one author warned against jumping to conclusions when he stated: "It will be noted that the differences all favor the good supervisors: that is, that they appear to be more intelligent, more stable, more dominant, more self-confident, and more sociable, but no difference even approaches statistical significance."[11]

A study made in the Indianapolis plant of the Radio Corporation of America may also be of interest. This study dealt with the selection of certain radio tube mounters and concluded: "Low intelligence scores tend to indicate the poorer worker. Average or above average scores did not discriminate between 'good' and 'fair' workers. All workers scoring below average in social adjustment had been rated only 'fair' by the supervisor, while all workers scoring above average in social adjustment had been rated 'good' by the supervisor. The supervisor had no previous knowledge of test scores."[7]

TRAINING

Training programs in industry are vital but expensive. Some of the expense involved is often due to poor initial selection of the employees to be trained, but, on the other hand, much expense can be attributed to poor methods of training. One study[14] showed that: "Hosiery mill employees with the poorest finger dexterity as measured by a dexterity test cost a company $59 each in minimum make-up before they made the rate, while employees having the best dexterity cost the company only $36.40. This study suggests that tests can answer three questions about

training: (1) Who should be trained? (2) Where should training begin? (3) Has training been adequate?"

In developing training programs, the psychologist has rendered the greatest aid through knowledge of techniques of teaching and principles of learning. Experiments on learning show that the following methods have genuine value:

1. The demonstration method, which gives the employee an over-all picture of the end results. Such techniques should be used sparingly and should be employed in progressive stages of the learning process.

2. Spaced learning, since it has been shown rather definitely that learning a task is mastered more quickly if practice is distributed. Few industries have made adequate use of this approach to learning.

3. Motivation, which has been shown to increase both the willingness and the ability to learn. The implications are that a trainer should praise an employee, show him his record of progress, etc.

4. Attention; getting the trainee to put his efforts in the right place. It is well to avoid the "don't's" and stress the "do's." The trainee should keep his eyes on the end results and not overdo the breaking down of acts into too many actions or steps.

WORK, FATIGUE, AND EFFICIENCY

The work habits of men differ markedly. To get the worker to become a better producer, for example, does not necessarily mean that mere time and motion studies hold the answer. A job performed by a particular worker according to his own pattern and sequence of movements may or may not be altered advantageously.

A recent study[10] throws some light on the complexity of the task: "Monotony, or boredom, is only one of many responses to work. Moreover, like many other expressions of dissatisfaction with work, it is a response to a total situation which includes not only the job but also the worker, with his own peculiar hopes and expectations, in relation to the collective life of the factory and the wider community."

Psychologists, in their study of fatigue, warn against using mere output figures as a measure. It has been found that many fatigue curves do not follow the normal pattern. Such unusual fatigue curves may be caused by one's reaction to a supervisor, by factors peculiar to one's own situation, by the group in which one works, etc. However, extremely heavy muscular work might follow the typical fatigue pattern somewhat more closely.

The investigations of the psychologist have shown that rest pauses are no panacea for solving problems of fatigue. If the worker feels that the rest pauses have been introduced as a disguised form of "speed up," he resents it and slows up production. If, on the other hand, he feels that management is sincerely interested in his health and well-being, he is likely to respond positively to the rest periods and, therefore, to speed up his work considerably.

The psychological implication of changing the physical conditions of work are not simple to determine or evaluate. It has been shown that changes of physical circumstances were not significantly responsible in themselves for variability of work. It appears that the variation in the attitude of the worker toward the various changes introduced was far more important than the actual physical changes that were made in the working conditions.

Psychology has made a substantial contribution to the whole field of motivating the worker and getting measures of morale. The A. C. Spark Plug Division of General Motors has reported:[5] "As a consequence of hiring only those scoring in the highest third on a battery of tests, the average production per operator was higher than the best previous individual record, and there was considerable improvement in worker morale on the job." In making these investigations, the psychologist has revealed that the worker is affected by many factors previously thought to be insignificant. He has drawn attention to these small factors and has shown how they build up the worker's attitude for good or ill.

There have been some advances made in detecting the industrial trouble-maker. To locate at the outset those workers who are likely to be at odds with their fellow employees and with their supervisors would be extremely helpful to management. Martin reports[9] that, in a study of a New York textile manufacturing concern, "A special test had identified 85 per cent of

the workers who had, in the management's opinion, demonstrated that they were 'trouble-makers and soreheads'." It may be that further research will reveal some valuable insight into workers' attitudes.

The data[10] gathered at the Hawthorne plant of the Western Electric Company indicate that an increase in wages by itself does not build "morale." The following summary raises some pertinent points: "At least two conclusions seem to be warranted from the test room experiments so far: (1) there was absolutely no evidence in favor of the hypothesis that the continuous increase in output could be attributed to the wage incentive alone: (2) the efficacy of a wage incentive was so dependent on its relation to other factors that it was impossible to consider it as a thing in itself having an independent effect on the individual." One other salient point: "When social conditions of work are such as to make it difficult for the employee to identify his task with a socially meaningful function, he is liable to obsessive response and diminished capacity for work."

Psychological investigations have revealed that certain individuals tend to be accident repeaters. Accident-prone individuals endanger others as well as themselves. The tendency to have accidents has been shown to be due, usually, to some faulty sense, such as touch, smell, color-blindness, balance, hearing, pressure, general coordination, etc. The failure of any one of these processes may not only endanger the life of the individual but could cost the lives of others about him. One investigator has reported[6] that by using a number of tests he was able to pick out many accident-prone individuals. He states that: "Individuals whose level of muscular action is above their level of perception are prone to more frequent and more severe accidents than those individuals whose muscular actions are below their perceptual level. In other words, the person who reacts quicker than he can perceive is more likely to have accidents than is the person who can perceive quicker than he can react."

In the foregoing discussion, a few of the many applications of psychology to industry have been touched upon. The need for well-controlled research studies to check the value of many of the methods and techniques of psychology is urgent. The results of scientific studies are likely to produce more efficient methods of evaluating, selecting, and training employees. Furthermore, such results will likely have a marked influence on the physical condition of the plants—lighting, ventilation, and arrangements of machines. More research and more rigid research are needed.

Applying psychology to industry—to dealing with people successfully—is at present more of an art than a science, but any good art or good science requires sound training based on tested principles.

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COLOR PHOTOGRAPHY IN FOOD FREEZING

Continued from Page 4

that it would not be economically feasible to make color photographs of large numbers of subjects unless 35 mm film was used for this purpose. This choice of film size has further limited the selection of color film to Ansco, since Ektachrome has not yet been produced in this size. A Leica camera with an f. 3.5 lens was selected for this work, and a Speed-O-Copy attachment was added. This equipment is recommended for the purpose by the majority of workers familiar with the field, and the instruments as they are being used at Georgia Tech can be seen in Figure 1, which shows the equipment *in situ* for making exposures for gross and microscopic studies.

By the use of the Speed-O-Copy attachment with the Leica camera, close-ups can be made simply and readily. The lens of the camera is fitted to the end of the proper extension tube, as shown in Figure 1; the use of the 30 mm tube enables pictures to be made which show the objects at about their original sizes, while the 60 and 90 mm tubes provide several diameters magnification. In addition, light intensity measurements can be made at the plane of the film by placing a short tube on top of the Speed-O-Copy, with neither the camera nor ground glass in place. The exposure meter is placed on top of the tube, and measurement is then made of the light field. The appearance of a colored object differs according to the kind of light by which it is viewed, so that the amount and quality of the light used in making exposures with color film is of the ut-

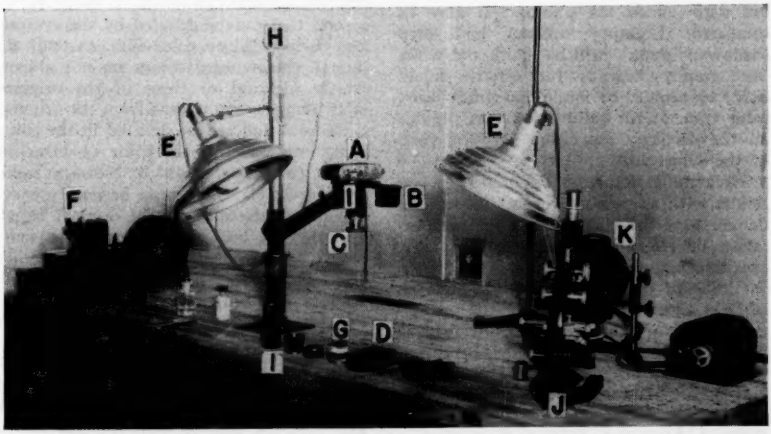

Figure 1. View of the photographic equipment as assembled for use in refrigerated work room.

A. Leica camera set in position to make exposures for gross and microscopic studies.

B. Ground-glass plate of the Speed-O-Copy attachment which can replace the camera and help the photographer make a very sharp focus.

C. The f. 3.5 lens fitted to the 60 mm. extension tube (see I. below).

D. The Weston exposure meter.

E. Photoflood lamps which may be adjusted manually to give varying intensities of light.

F. The microtome, used for making fine sections for microscopic study.

G. Tube used on top of Speed-O-Copy to make light intensity measurements at a point identical to that of the exposure.

H. Stationary column supporting the Speed-O-Copy attachment.

I. Extension tubes of 30, 60, and 90 mm. which are used to give various magnifications.

J. The microscope.

K. The lamp, used to illuminate microscopic studies.

most importance. Color films are manufactured to give correct color rendition for a definite color of light, so that illumination must be of the quality for which the film is balanced. In making indoor exposures with artificial light, correct lighting requires absolute exclusion of daylight because the mixture of daylight and photoflood light results in a "duo" effect that cannot be controlled.

The color of the surroundings may be reflected to the subject, so that care in selection of the background is also essential. The background color should be enough lighter or darker than the subject to afford contrast, but not so much lighter or darker that it will not photograph properly. A background of a color complementary to the principal color of the subject can be quite effective. The use of a colored background increases resolution in the transparencies, so that details are more easily seen, and also provides standard colors with which the photograph may be compared. Lighting contrast and deep shadows, upon which black-and-white photography depends for effect, should either be avoided or minimized when using color film, as the color differences provide all the necessary separation between parts of the subject.

Accurate exposure is essential for best results with any color process. Color films do not have the wide latitude for compensation of errors in lighting and exposure possessed by many black-and-white films. In order to determine the proper amount of light and exposure time for the production of good transparencies when using a particular set-up, a large number of exposures must be made at various time intervals and with varying amounts of light. For the work on frozen foods using Ansco tungsten film, two 3200° K. lamps are employed. These are held in standard reflectors and mounted so that their positions may be easily changed. In order to determine the proper conditions, transparencies made under various conditions were compared with the original subjects, and optimum conditions thus determined. Lighting angles of 45° to 90° gave the best transparencies. In all cases, the camera range setting was infinity, and it was found preferable to use a lens stop of f. 3.5. "Stopping-down" gave more depth to the finished transparencies, but the resolution was considerably less. A light intensity reading of 2.4 on the Weston meter at a 0.25-second exposure time gave the most satisfactory results with the present set-up.

In order to carry out the development of color film, it is necessary to control the temperature of the solutions used, and, for this reason, the darkroom used for this color work at the Georgia Tech Engineering Experiment Station was equipped with a small air conditioning unit, controlled by a thermostat so that the temperature of the darkroom is held at 68° F.—the recommended temperature for proper development.

RESULTS

The results of the experimental work with color transparencies have been applied very satisfactorily to the recording of the colors of foods. In general, it can be said that the slightest variation in the color of a food that can be detected by the eye can also be recorded on color film, so that, although the recorded colors are not always exactly identical to those of the original in all respects, any change from the original is recorded and can be detected in the color film. For example, the color of blanched beans (a product which becomes more green upon blanching) can be readily compared with the color of the original beans. Records have been made of numerous samples of foods which have been frozen, and, after a storage period of a year, more photographs will be prepared for comparison purposes, so that any color changes can be detected.

It must be pointed out that the equipment necessary for the production of good color transparencies is relatively expensive and that the cost of each transparency is also high. However, by the method described here, records have been made of colors of foods which are superior to those which have been obtained by any other method that has been tried in the research on frozen foods at Georgia Tech.

ACKNOWLEDGEMENT

The technical assistance and advice of Mr. J. E. Garrett, head of the Engineering Experiment Station's Photographic Laboratory, is gratefully acknowledged.

FOREST PROBLEM

Continued from Page 12

in terms of management status, the per cent acreage distributions are:

	Management Status*			
	Intensive	Extensive	Without	Non-operating
U. S., All Ownerships	2.1	33.4	51.9	12.6
U. S., Farm	0.1	16.9	71.8	11.2
South, All Ownerships	2.9	18.7	68.5	9.9
South, Farm	—	13.8	74.3	11.9
Southeast, All Ownerships	1.9	15.0	76.9	6.2
Southeast, Farm	—	9.7	83.0	7.3

*Per cents of acreage.

Georgia, being in the "Southeast" subgroup of the "South," is more likely to be characterized by the "Southeast" figures than by those for the "South." In any case, however, the preceding recent figures are not favorable for Georgia and the Southeast.

Comparison of the same percentages for farm and "large private holdings" (over 50,000 acres), however, does throw some light on both the present conditions and future possibilities:

	Management Status*			
	Intensive	Extensive	Without	Non-operating
U. S., Large Private Holdings	3.7	44.0	48.4	3.9
U. S., Farm	0.1	16.9	71.8	11.2
South, Large Private Holdings	7.5	29.1	60.8	2.5
South, Farm	—	13.8	74.3	11.9
Southeast, Large Private Holdings	3.9	28.9	65.5	1.7
Southeast, Farm	—	9.7	83.0	7.3

*Per cents of acreage.

This last tabulation suggests that it is very probably easier to improve forest management practices on large tracts of land than on small ones. For one thing, it is much easier with 50,000 or 100,000 acres of land to select areas for harvest and thus to secure a more even annual income from sawlogs than it is to do the same thing with only 50 or 100 acres. Fire protection becomes more economical on a large tract. Forest management specialists could probably point out a long series of advantages which the owner of 50,000 acres has over the average farmer.

These things are all reflected in the poorer care which farm wood lots appear to receive and in their poorer average production, which the *Atlanta Federal Reserve Bank Bulletin** estimates as being "about one third what it should be."

While the Forest Service did not, in its summary, make specific recommendations regarding the farm wood lots, it appears obvious from the general context that the potential education of individual farmers in good forest management must have been assumed if the results indicated in the 75-year estimates are to be obtained.

Seventy-five years is a long time. It requires a great deal of altruism and faith to attack problems which require generations to secure the full benefit. As has already been pointed out, forest problems are more easily solved where the would-be solver has control of many thousands of acres than where thousands of individuals must each work the problem out on a few acres.

From a state or regional point of view, it would be much more practical to find some sound method by which the many thousands of farm timber holdings could be operated as a series of unified tracts of fifty thousand or more acres each. Three general ways of effecting such a consolidation appear practical. The first calls for a management cooperative which could control the land, operate it for the members, and distribute profits annually; the second method involves a stock company which would provide operating capital and management but which would, as largely as possible, acquire land in exchange for stock; and the third way involves a stock company which would purchase all land required and operate entirely independently of the former owners.

Each of these three general schemes appears to have advantages and disadvantages.

A cooperative, which is approved by most people with whom the idea has been discussed, may meet with difficulty in finding a large enough number of farmers willing to work together over a sufficiently long period for the idea to prove its merits. In the meantime, since it is inevitable that in any one year the bulk of the sales revenue would be derived from only a few of the original tracts while visible values

*May 31, 1947.

would be accumulating on most of the others, individuals might want to withdraw.

Both the second and third general methods, since they are based on passing title to a corporation, would avoid this difficulty. The second plan, however, seems to have two advantages over the third: (1) most of the original owners would remain as stock holders, and (2) this would reduce the amount of new money required. Under any such plan, the farm wood lots which will become easily available for inclusion in larger tracts will of course be those which are now receiving the *least* management, which are producing the *least* income, and on which the standing timber is of somewhat *less* value per acre than the average. From the long-range point of view, this represents no disadvantage for the plan, since it concentrates improvement on the worst part of the situation. The expectation, then, should be that the improvement rate would be accelerated.

Assuming, for example, that about one tenth of the farm wood lots in Georgia were consolidated into a series of larger tracts; that within ten years these tracts all attain a "high order" of cutting standards and "good" fire protection, thus qualifying for an intensive management status; and that Georgia forest characteristics are the same as those of the Forest Service's "Southeast," the management status previously quoted would become, with no other change:

	Management Status*			
	Intensive	Extensive	Without	Non-operating
Georgia, Farm	10.0	9.7	75.0	4.8
Southeast, Farm	3.1	9.7	80.7	6.5

*Per cents of acreage.

While at first glance this plan still leaves large areas under poor management, the sharp increases in the acreages under intensive management control would provide the examples which would stimulate more rapid improvement in the next and succeeding decades.

These ideas are presented with the hope of provoking discussion, thinking, and action. Constructive action on the farm wood lot problem may well cut years from balancing the forest problem nationally and add greatly to both agricultural and industrial wealth in Georgia and the Southeast.

EDITORIAL POLICY

Continued from Page 2

statement, other than the return question: "Why is the article to be included at all; what purpose does it serve?" If this is clear, the answers to the earlier questions are easy to provide.

The Georgia Tech Engineering Experiment Station, naturally, hopes that this journal and all its other publications are contributing information needed by or of interest to individuals and industries for many and varied purposes. If you have any suggestions to offer, so that these efforts may be more successful, we would be very grateful to receive them.

RECENT STATION PUBLICATION

Anderson, Betty and Weil, B. H., *First Supplement, January, 1946-July, 1947, to the Literature Search on the Preservation of Foods by Freezing.* State Engineering Experiment Station Special Report No. 25, 1948, 272 pages. $3.00 in U. S.; $3.50 foreign.

More and more research is being conducted on frozen foods. New processes are being developed; new foods are continually being added to the list of frozen products. Much is being learned about varietal selection, handling, prefreezing treatment, packaging, storage, transportation, and marketing.

This *First Supplement* was prepared to bring up to date the Station's 1946 literature search (Special Report No. 23) on these subjects. So fast a pace is being set in the field of frozen foods that 1,284 pertinent literature and patent abstracts are included for the 19-month period covered by the search.

The original literature search and this supplement provide an indexed, expanded bibliography of the pertinent literature, compiled in order that future research may benefit through use of and acquaintance with the existing data.

All phases of food freezing are covered, including—this time—the freezing of dairy products. A detailed, alphabetical subject index makes possible access to references in many divisions of the field.